

500,704

10/500704
Rec'd PCT/PTO 02 JUL 2004

(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau



(43) International Publication Date
10 July 2003 (10.07.2003)

PCT

(10) International Publication Number
WO 03/056133 A1

(51) International Patent Classification⁷: E21C 37/14

(21) International Application Number: PCT/ZA02/00212

(22) International Filing Date:
17 December 2002 (17.12.2002)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
2001/5466 3 January 2002 (03.01.2002) ZA

(71) Applicant and

(72) Inventor: VAN DYK, Andre [ZA/ZA]; 223 Eland Street,
Wierda Park, Centurion, 0002 Pretoria (ZA).

(74) Agents: MCCALLUM RADEMEYER & FREIMOND
et al.; PO Box 1130, 7 Maclyn House, Bordeaux, 2125
Randburg (ZA).

(81) Designated States (*national*): AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DZ, EC, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ, NO, NZ, OM, PH, PL, PT, RO, RU, SD, SE, SG, SK, SL, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, YU, ZA, ZM, ZW.

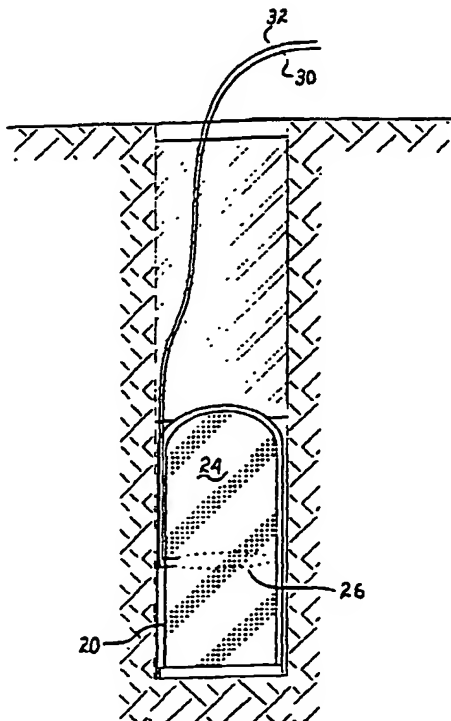
(84) Designated States (*regional*): ARIPO patent (GH, GM, KE, LS, MW, MZ, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE, SI, SK, TR), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

Published:

— with international search report

For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

(54) Title: ELEMENT FOR INITIATING PROPELLANT



(57) Abstract: Apparatus for breaking rock which includes a cartridge (16) which forms an enclosure, a propellant (24) inside the enclosure, and at least one element (26) which is electrically energisable and which is made from inert material exposed to the propellant.



WO 03/056133 A1

ELEMENT FOR INITIATING PROPELLANTBACKGROUND OF THE INVENTION

This invention is concerned generally with a customized low energy method of breaking rock in a controlled manner.

5 As used herein the word "rock" includes rock, ore, coal, concrete and any similar hard mass, whether above or underground, which is difficult to break or fracture. It is to be understood that "rock" is to be interpreted broadly.

A number of techniques have been developed for the breaking of rock using non-explosive means. These include a carbon dioxide gas pressurisation method
10 (referred to as the Cardox method), the use of gas injectors (the Sunburst technique), hydrofracturing and various methods by which cartridges containing energetic substances pressurise the walls or base of a sealed drill hole to produce penetrating cone fractures (known as PCF).

These techniques may be an order of magnitude more efficient than conventional
15 blasting in that they require approximately 1/10 of the energy to break a given amount of rock compared to conventional blasting using explosives. The lower energy reduces the resulting quantity of fly rock and air blast and to an extent allows the rockbreaking operation to proceed on a continuous basis as opposed to the batch-type situation, which prevails with conventional blasting.

20 Most non-explosive rockbreaking techniques rely on the generation of high gas pressures to initiate a tensile fracture at the bottom of a relatively short drill hole.

As used herein the term "propellant" is to be interpreted broadly to include a blasting agent, propellant, gas-evolving substance, explosive or similar means which, once initiated, generates high pressure jet material typically at least partly in gaseous form. Propellants of this nature are known in the art. "Blasting agent" and "propellant" are used interchangeably in this specification.

SUMMARY OF INVENTION

The invention provides apparatus for breaking rock which includes a cartridge which forms an enclosure, a propellant inside the enclosure, and at least one element which is electrically energisable and which is made from inert material exposed to the propellant.

As used herein "inert material" means a material which, unless energised, cannot give rise to a spark or other phenomenon which can initiate the blasting agent.

The element may be in the nature of a filament or electrical resistor.

The element may be made from any appropriate material but a preferred material is carbon, eg. in the form of graphite.

The element may be treated in any appropriate way to enhance the efficiency with which the propellant is initiated. For example the element may be dipped in or coated with aluminium powder or any similar agent which gives rise to a sputtering effect when the element is energised.

The element may be in the nature of a fusible link ie. a portion of the element may be disintegrate when an electric current in excess of a predetermined amount is passed

through the element. Disintegration of the element gives rise to the generation of high energy and relatively small particles which are propelled into the propellant thereby to initiate combustion of the blasting agent. This approach should be contrasted with a technique wherein the element in the form of a filament wire is heated by the passage of electric current to a higher temperature at which the propellant is initiated but wherein the filament remains integral and does not disintegrate due to the direct effect of the electric current passing through the filament.

The filament may be coated to prevent the propellant, or moisture in the propellant, from reacting or fusing with the material contained in the filament.

The filament may for example be a wire or band made from aluminium, nickel-chrome, carbon or a similar material, or a resistor such as a ceramic metal device which, when energized, does not fuse or disintegrate but instead, remains integral despite dissipating sufficient heat to initiate combustion of the propellant.

The cartridge may include a base and a side wall which extends from the base. The side wall may be generally cylindrical.

The cartridge may be made from a malleable material which, in this sense, includes a material which is capable of plastic deformation, without fracture, at least to a predetermined extent.

The cartridge is preferably made from a plastics material eg. polypropylene, polyethylene or the like. The scope of the invention is not limited in this regard.

An upper end of the cartridge, ie. an end which opposes the base, may be domed and the filament may be located at the upper end.

It falls however within the scope of the invention to locate the filament at an intermediate location ie. between opposing ends of the cartridge.

5 The filament may be relatively small and thus, when energized, cause the production of a localized relatively high energy hot spot. On the other hand the filament may be elongate so that, when energized, the propellant is initiated over a fairly substantial length or area or at a plurality of points.

10 It falls within the scope of the invention to include more than one element in the cartridge so that initiation of the propellant takes place at more than one location. Electrical leads to the element may be positioned inside the cartridge or on an outer surface of the cartridge but preferably are embedded in the material from which the cartridge is made.

15 The electrical leads may be connected to terminals to facilitate connection of the leads to a control unit. The terminals are preferably on an outer side of the cartridge.

The terminals may be covered with a removable closure. Alternatively the terminals may be covered with a frangible or breakable closure. The closure is designed to protect the terminals from damage or exposure prior to use of the cartridge.

20 The element, or elements, as the case may be, with suitable leads or conductors to the elements and, where applicable control devices such as timing circuits and capacitors or other energy sources for operating the timing circuits, may be mounted

on a suitable substrate or motherboard, to facilitate handling of these components and assembly thereof together with the remainder of the cartridge.

The invention also extends to an element of the aforementioned kind, and to a substrate which carries the element and, where required, one or more components for use with, or required to energize, the element.

BRIEF DESCRIPTION OF THE DRAWINGS

The invention is further described by way of examples with reference to the accompanying drawings in which:

Figure 1 is a view in cross section and from the side of blasting apparatus according to one form of the invention,

Figures 2 and 3 are views similar to Figure 1 of blasting apparatus according to second and third forms of the invention,

Figure 4 is an enlarged cross sectional view of a portion of a cartridge illustrating connecting terminals on the cartridge, and

Figure 5 shows a substrate which carries a filament, for use in the apparatus of the invention.

DESCRIPTION OF PREFERRED EMBODIMENTS

Figure 1 of the accompanying drawings illustrates a hole 10 which is drilled into a rock mass 12 from a face 14 using conventional drilling equipment. A cartridge 16 is loaded into the hole. In this example the cartridge has a base 18 and a generally cylindrical wall 20 which extends from the base and which terminates at an upper end, remote from the base, in a rounded shape 22.

The cartridge is made from a plastics material using injection techniques which are known in the art. The cartridge is for example made from a high density plastics material such as high density polypropylene.

5 It is desirable to form the cartridge from a malleable material which enables the cartridge to be plastically deformed, without rupture, at least to a predetermined extent eg. of the order of 10%, or more.

The cartridge forms an enclosure for a propellant material 24 which is of known composition. The propellant is loaded into the cartridge under factory conditions using techniques which are known in the art.

10 An initiator 26 is located at an upper end of the cartridge. The initiator has an element when, in this case, is in the form of a filament made from inert material such as carbon wire which, preferably, is formed into a coil or with a zig zag configuration. The filament extends from two leads 30 and 32 which pass through the wall of the cartridge so that filament is exposed, in the interior of the cartridge, to the propellant
15 24. The leads 30 and 32 extend to a blasting control unit, not shown, of a type which is known in the art.

Stemming 40 is placed into the hole from the rock face covering the cartridge to a desired extent and is consolidated by being tamped in position.

20 The filament is energized by sending a signal of a determined energy content through the wires 30 and 32 to the filament. The filament is thereby heated and glows creating, in effect, a localized hot spot which transfers sufficient energy to the propellant, in the immediate vicinity of the filament, to cause ignition of the propellant.

The propellant, when ignited, causes the release of high pressure jet material which is substantially in gaseous form. This material produces a shock wave which is used to fracture the rock 12, typically with an initial fracture being established at the bottom 40 of the hole 10.

5 The carbon filament 26 is, as noted, inert and consequently it is possible to provide the cartridge 16 in a form which is ready for use in the sense that the propellant 24 can be loaded into the cartridge even though the initiator 26 is already fixed to the cartridge. In many other instances it is not possible to provide the cartridge, loaded with propellant, if the initiator is already fixed to the cartridge for it is possible
10 inadvertently to energise the initiator and thus cause unwanted combustion of the propellant. Due to the fact that the filament is made from an inert material it is believed that this danger is effectively eliminated.

The filament may be coated with aluminium paint which, when heated, increases the quantity of energy which is released and, depending on circumstances, can give rise
15 to a sputtering effect which enhances the efficiency with which the propellant is ignited.

The filament could alternatively be in the form of a wire or band and could be made from aluminium or nickel-chrome. These materials may be of a kind which, when heated by electric current, fuse and disintegrate. In a variation use is made of a
20 suitable resistor, made for example from a ceramic/metal composition which, when heated, glows but does not spatter or disintegrate, and which provides the necessary "hot spot" to initiate combustion.

The arrangement shown in Figure 2 is similar in many respect to what is shown in Figure 1 and where applicable like reference numerals are used to designate like components. The filament initiator 26 is, however, in this case located at a position more or less midway between the base 18 and the rounded upper end of the cartridge. The leads 30 and 32 extend from an upper entry point to the filament and are embedded in the wall 20 of the cartridge. The filament 26 is fired in the same way as what has been described in connection with Figure 1.

In the arrangement shown in Figure 3 the filament is not localized in the way shown in Figures 1 and 2 but, instead, is elongate. The filament extends from end points of wires 30 and 32 which, as is the case with the Figure 2 embodiment, are embedded in the side wall 20. The filament is shaped into the form of a ring which extends around an internal surface of the wall 20. Consequently, when the filament is initiated, combustion of the propellant 24 takes place over an extended length or area or, otherwise put, at a plurality of points.

The filament 26 may be designed and operated so that when energized it is heated to glow and cause a localized temperature increase of sufficient magnitude to initiate the blasting agent. Alternatively the filament may be in the form of a fusible link such that a region of the filament is heated to disintegration point by the passage of electrical current. Components of the filament which are released upon disintegration are extremely hot and a sputtering-type action results as the filament disintegrates.

It is possible to enhance the combustion effect of the filament by coating the filament at one or more locations with an agent such as aluminium powder or any other substance which is explosive or flammable by nature. Again small localized hot

spots are generated when an appropriate electrical current is passed through the filament and combustion of the propellant is therefore initiated effectively simultaneously at a plurality of locations.

Also, to protect the filament against reacting with the propellant, or moisture in the propellant, the filament may be coated with an inert material such as a suitable lacquer, eg. of nitrocellulose.

Figure 4 is an enlarged view in cross section of an upper end 22 of a cartridge which may be of the type shown in any one of Figures 1 to 3. The leads 30 and 32 are, as has been described, embedded in the wall 20 of the cartridge and terminate in relatively rigid terminals 50 and 52 respectively, which project outwardly from the cartridge. The terminals are covered by means of a cap 54 which protects the terminals during transport and storage of the cartridge. If the terminals are to be accessed to enable electrical connections to be made to the terminals then the cap is removed. The cap may for example be threadedly engaged with the cartridge. Alternatively the cap may be formed substantially integrally with the cartridge or be secured thereto in a manner which inhibits removal of the cap. In this case the cap includes a lid 56 which is breakable, or which can be torn from the remainder along a line of weakness, not shown, to expose the terminals so that electrical connections can be made thereto.

Figure 5 illustrates another modification which can be made to the aforementioned principles. Figure 5 shows a cartridge 10 which is filled with propellant 24. A substrate 60 is located in the cartridge. The substrate is made from an inexpensive non-electrically conductive material, and may be in the nature of a printed circuit

board, be formed from a suitable plastic material, or the like. The substrate may be rigid or flexible.

Discrete components may be mounted directly to the substrate using techniques which are known in the electronics art. Alternatively components may be formed on the substrate using deposition techniques similar to those employed in the manufacture of printed circuit boards, integrated circuits and the like.

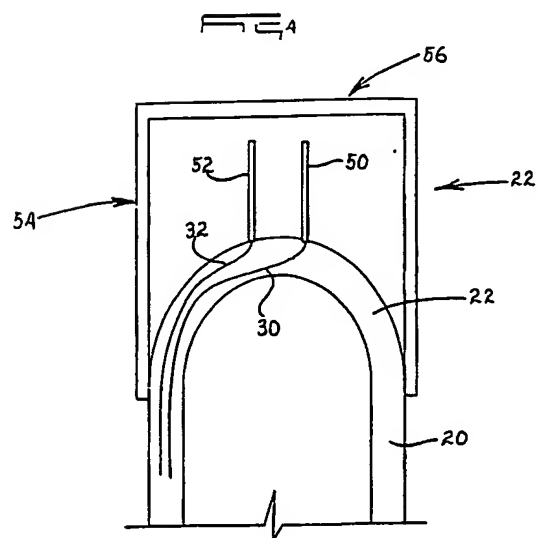
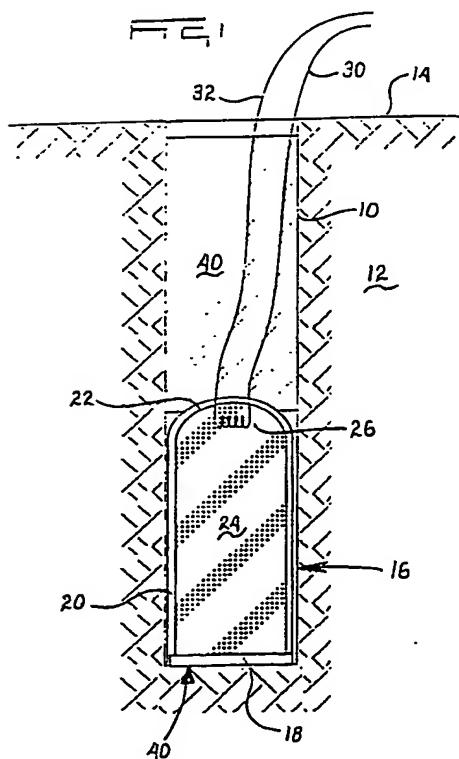
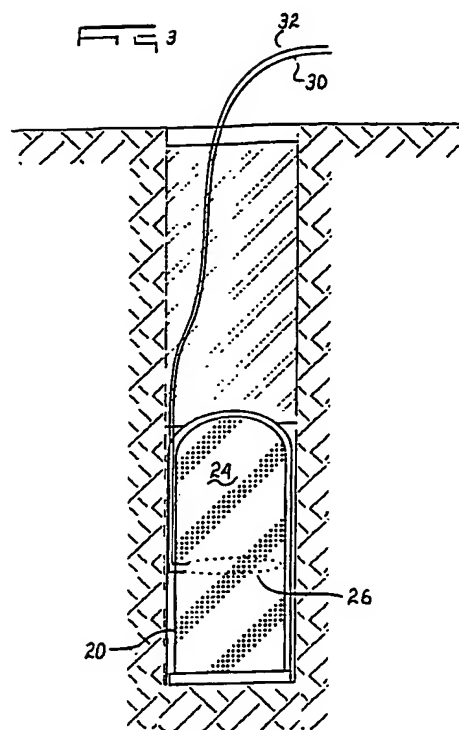
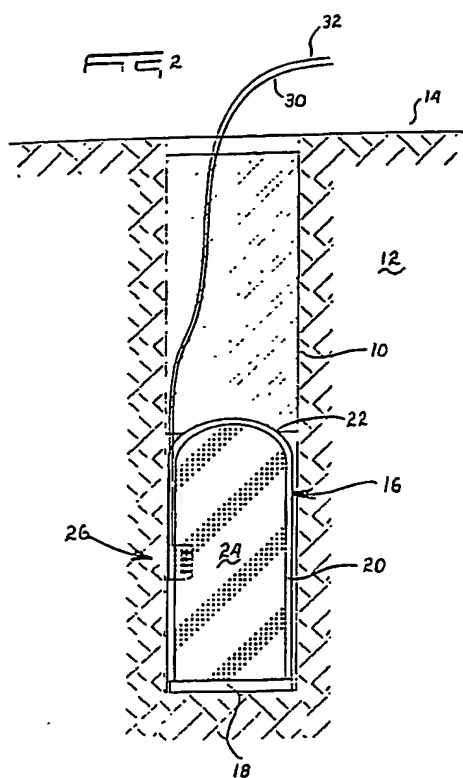
Thus, using an appropriate technique, a filament 26 is formed on, or is mounted to, the substrate and leads 62 are formed connecting the substrate to a timing circuit 64. The circuit is also formed on or bonded to the substrate and includes leads 66 which extend to terminals 68. The conductors 30 and 32, which are inherently more robust than the leads 62 and 64 on the substrate, are directly connected to the terminals.

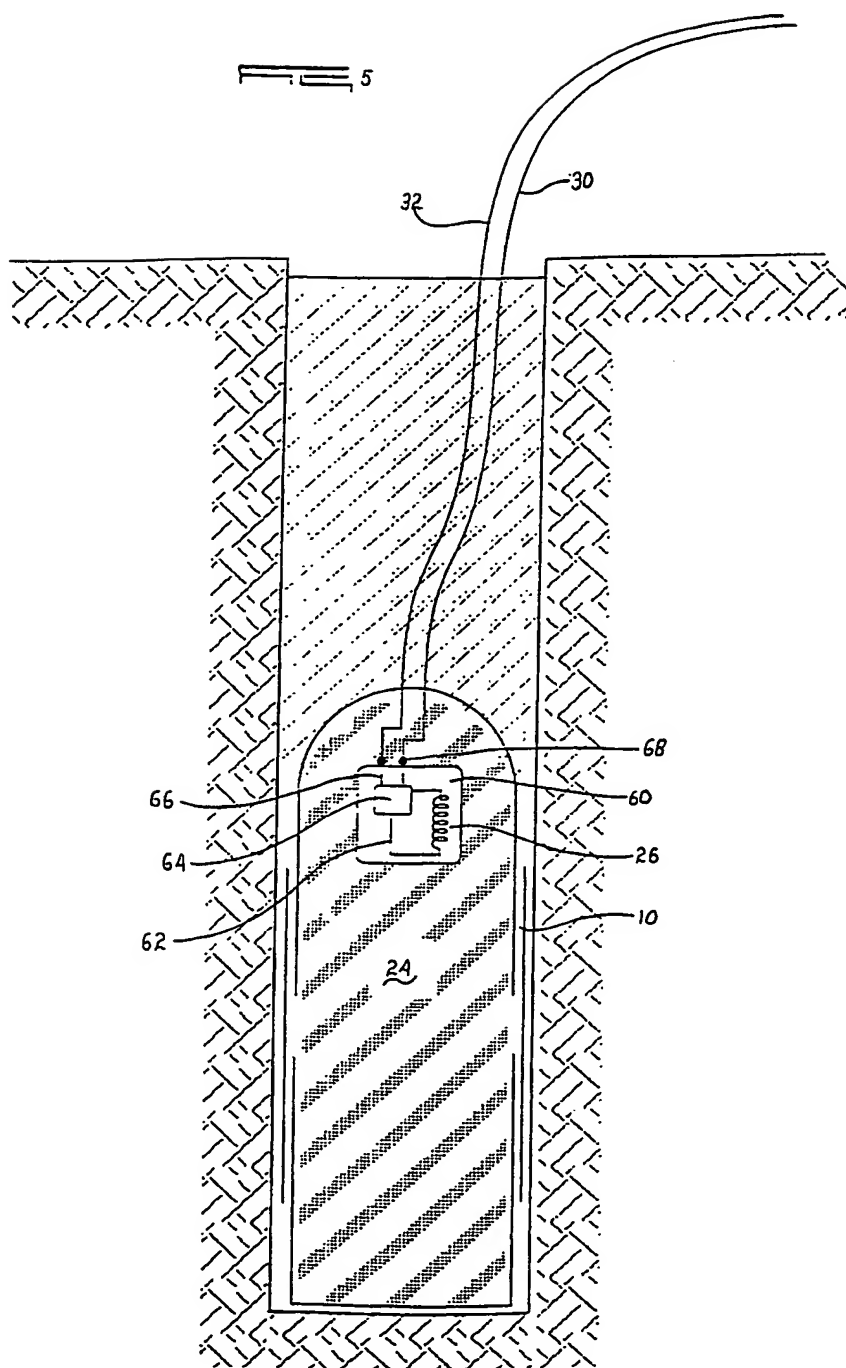
The use of the substrate to carry the filament considerably facilitates the manufacture of the filament and its use and helps in reducing inadvertent damage to the filament which could arise during manufacture of the cartridge or when the cartridge is installed in a hole in a rock face. The substrate may be of any appropriate shape or size so that when the substrate is positioned inside the cartridge the filament 26 is substantially automatically positioned at a desired location inside the cartridge. Clearly it is possible to form a plurality of filaments on the substrate so that the individual filaments are at precisely determined locations relatively to each other inside the cartridge.

CLAIMS

1. Apparatus for breaking rock which includes a cartridge which forms an enclosure, a propellant inside the enclosure, and at least one element which is electrically energisable and which is made from inert material exposed to the propellant.
5
2. Apparatus according to claim 1 wherein the element is made from a material selected from carbon, graphite, aluminum, and nickel-chrome.
3. Apparatus according to claim 1 or 2 wherein the cartridge is made from a malleable material and includes a cylindrical side wall, a base and a domed end which opposes the base.
10
4. Apparatus according to any one of claims 1 to 3 which includes electrical leads which extend from terminals on an outer side of the cartridge to the element.
5. Apparatus according to claim 4 which includes a removable closure which covers the terminals.
15
6. Apparatus according to any one of claims 1 to 5 which includes a substrate on which the element is mounted and which is embedded in the propellant.
7. Apparatus according to claim 6 which includes a control device, for controlling operation of the element, on the substrate.

8. Apparatus according to any one of claims 1 to 7 wherein the element is in the form of an elongate filament.





INTERNATIONAL SEARCH REPORT

International Application No

PCT/ZR 02/00212

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 E21C37/14

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC 7 E21C

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	EP 0 872 317 A (HITACHI SHIPBUILDING ENG CO) 21 October 1998 (1998-10-21) column 7, line 38 -column 8, line 12; figure 13 column 6, line 41 ---	1-4, 8
X	EP 0 858 874 A (HITACHI SHIPBUILDING ENG CO) 19 August 1998 (1998-08-19) column 7, line 34 -column 8, line 24; figure 8 column 5, line 6 ---	1, 3, 4, 6-8
X	WO 01 65199 A (ROCKTEK LTD ;TOTA EDWARD (AU)) 7 September 2001 (2001-09-07) page 7, line 17 -page 8, line 20; figure 9 -----	1

☐ Further documents are listed in the continuation of box C.

Patent family members are listed in annex.

* Special categories of cited documents:

- *A* document defining the general state of the art which is not considered to be of particular relevance
- *E* earlier document but published on or after the international filing date
- *L* document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
- *O* document referring to an oral disclosure, use, exhibition or other means
- *P* document published prior to the international filing date but later than the priority date claimed

- *T* later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
- *X* document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
- *Y* document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.
- *&* document member of the same patent family

Date of the actual completion of the international search

3 April 2003

Date of mailing of the international search report

25/04/2003

Name and mailing address of the ISA

European Patent Office, P.B. 5818 Patentlaan 2
NL - 2280 HV Rijswijk
Tel. (+31-70) 340-2040, Tx. 31 651 epo nl,
Fax: (+31-70) 340-3016

Authorized officer

Ott, S

INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No

PCT/ZA 02/00212

Patent document cited in search report		Publication date	Patent family member(s)	Publication date
EP 0872317	A	21-10-1998	JP 3103015 B2	23-10-2000
			JP 9029731 A	04-02-1997
			JP 3192928 B2	30-07-2001
			JP 9038947 A	10-02-1997
			JP 3169533 B2	28-05-2001
			JP 9038948 A	10-02-1997
			EP 0872317 A1	21-10-1998
			US 6145934 A	14-11-2000
			CN 1185766 A	24-06-1998
			EP 1172629 A1	16-01-2002
			EP 1172630 A1	16-01-2002
			WO 9703796 A1	06-02-1997
			RU 2159852 C2	27-11-2000
EP 0858874	A	19-08-1998	JP 3103016 B2	23-10-2000
			JP 9029732 A	04-02-1997
			JP 3103017 B2	23-10-2000
			JP 9029733 A	04-02-1997
			EP 0858874 A1	19-08-1998
			KR 261458 B1	01-07-2000
			US 6283555 B1	04-09-2001
			CN 1185130 A	17-06-1998
			WO 9703797 A1	06-02-1997
			RU 2165526 C2	20-04-2001
WO 0165199	A	07-09-2001	WO 0165199 A1	07-09-2001
			AU 3524001 A	12-09-2001
			BR 0108798 A	31-12-2002
			EP 1281039 A1	05-02-2003
			US 2002014176 A1	07-02-2002